CLAIMS

What is claimed is:

1. An apparatus for laser interrogation of surface agents moving relative to the apparatus, said apparatus comprising:

a laser, said laser outputting an output beam;

a beam-focusing telescope having a axis of transmission, said beam-focusing telescope receiving and focusing substantially said output beam;

a first reflector substantially aligned with said axis of transmission for directing said output beam in a first direction, said first direction being substantially perpendicular to the axis of transmission;

a second reflector substantially aligned with said first direction for directing said output beam in a second direction, said second direction being substantially perpendicular to said first direction;

a receiver telescope, said receiver telescope having a focal direction substantially opposite to said second direction, said receiver telescope comprising further:

a primary reflector, said primary reflector disposed to reflect at least some radiation scattered inelastically from a target;

a focusable secondary reflector disposed to reflect and focus said inelastically scattered radiation toward a first focal point;

a secondary reflector focusing mechanism to move said focusable secondary reflector along said focal direction;

a spectrograph, said spectrograph receiving said inelastically scattered radiation from said receiver telescope;

a range-finder, said range-finder outputting a distance-to-target signal in a third direction;

wherein said third direction is at a predetermined non-zero angle to said second direction in a direction of said relative motion; and

wherein said focusing mechanism moves said secondary reflector based on said distance-to-target signal and a rate of said relative motion to focus substantially said inelastically scattered radiation at said first focal point.

2. The apparatus of claim 1, wherein said range-finder is a laser range-finder.

3. The apparatus of claim 1, wherein said first reflector transmits substantially visible light.

4. The apparatus of claim 1, wherein said second reflector transmits substantially visible light.

5. The apparatus of claim 1, wherein said primary reflector transmits substantially visible light.

6. The apparatus of claim 1, wherein said secondary reflector transmits substantially visible light.

7. The apparatus of claim 1, wherein said focusing mechanism comprises an actuator selected from the group consisting of:

a voice coil actuator,

an electric motor,

a piezoelectric actuator,

a linear motor,

a pneumatic actuator, and

a hydraulic actuator.

8. The apparatus of claim 1, wherein said rate of said relative motion defaults to a predetermined constant.

9. The apparatus of claim 1, wherein:

a portion of said output beam is at a predetermined wavelength, and said predetermined wavelength is less than approximately 253 nm.

10. The apparatus of claim 9, wherein:

said predetermined wavelength is 248 nm.

11. The apparatus of claim 9, wherein said primary reflector transmits substantially radiation at said predetermined wavelength.

12. The apparatus of claim 9, wherein said secondary reflector transmits substantially radiation at said predetermined wavelength.

13. The apparatus of claim 1, wherein a portion of said output beam is of a predetermined polarization.

14. The apparatus of claim 13, wherein said output beam comprises further ASE, said ASE being substantially unpolarized;

said apparatus comprising further a polarized reflector aligned substantially with said axis of transmission, said polarized reflector transmitting said ASE.

15. The apparatus of claim 13, wherein said output beam comprises further ASE, said ASE being substantially unpolarized;

said apparatus comprising further a polarized reflector aligned substantially with said axis of transmission, said polarized reflector reflecting said ASE.

16. The apparatus of claim 1, comprising further an aluminum honeycomb structure; and

wherein said laser, said beam-focusing telescope, said first reflector, said second reflector, said range finder, and said receiver telescope are fixedly disposed on said structure.

17. The apparatus of claim 16, wherein said structure comprises a predetermined coefficient of thermal expansion.

18. The apparatus of claim 16, wherein said laser, said beam-focusing telescope, said first reflector, said second reflector, said receiver telescope, said primary reflector, said focusable secondary reflector, and said range-finder comprise further said predetermined coefficient of thermal expansion.

19. The apparatus of claim 16, wherein said aluminum honeycomb structure comprises further a carbon epoxy covering.

20. The apparatus of claim 16, wherein one of said laser, said beam-focusing telescope, said first reflector, said second reflector, said range finder, and said receiver telescope are fixedly disposed on said structure with a fastener, said fastener selected from the group consisting of:

a screw,

a bolt,

a rivet, and

a pin.

21. The apparatus of claim 1, wherein said laser emits pulses at a pulse rate, and said pulse rate is selected from the group consisting of:

a predetermined pulse rate,

a variable pulse rate,

an operator-controlled pulse rate, and

a pulse rate proportional to a rate of said relative motion.

22. The apparatus of claim 1, further comprising:

a receiver telescope filter coincident with said focal direction, said filter being substantially opaque to elastically scattered radiation.

23. The apparatus of claim 22, wherein said receiver telescope filter is integral with said receiver telescope.

24. The apparatus of claim 23, wherein said receiver telescope filter is integral with said primary reflector.

25. The apparatus of claim 22, wherein said receiver telescope filter is an edge filter.

26. The apparatus of claim 1, wherein said laser is an Alexandrite laser.

27. The apparatus of claim 26, wherein said laser is a line-narrowed Alexandrite laser.

28. The apparatus of claim 1, wherein said laser is an Excimer laser.

29. The apparatus of claim 28, wherein said laser is a line-narrowed Excimer laser.

30. The apparatus of claim 28, wherein said laser comprises further a replaceable gas bottle.

31. The apparatus of claim 1, wherein said apparatus is substantially resistant to a decontamination chemical.

32. The apparatus of claim 1, comprising further:

an optical fiber coupling said inelastically scattered radiation from said receiver telescope to said spectrograph.

33. The apparatus of claim 1, wherein said optical fiber comprises a bundle of optical fibers.

34. The apparatus of claim 32, wherein said optical fiber comprises further a first end and a second end;

said first end being substantially coincident with said first focal point to collect said inelastically scattered radiation;

said spectrograph comprising further:

a parabolic reflector, said second end being substantially coincident with a focal point of said parabolic reflector to disperse said inelastically scattered radiation;

said parabolic reflector disposed to reflect said dispersed inelastically scattered radiation toward a diffraction grating, said diffraction grating diffracting said dispersed inelastically scattered radiation; and

a focal plane array detector receiving said diffracted inelastically scattered radiation.

35. The apparatus of claim 34, wherein:

said focal plane array detector has a first predetermined geometry;

said optical fiber comprises a circular-to-line optical fiber having a second predetermined geometry; and

said second predetermined geometry matches said first predetermined geometry.

36. The apparatus of claim 34, wherein said focal plane array detector is selected from a group consisting of:

an intensified charge coupled device, and

a charge coupled device.

37. The apparatus of claim 34, wherein said second end is centered in said diffraction grating.

38. The apparatus of claim 34, wherein said second end is integral to said diffraction grating.

39. The apparatus of claim 1, wherein said output beam comprises wavelengths other than said predetermined wavelength, said apparatus comprising further:

an output filter adapted to attenuate said wavelengths other than said predetermined wavelength.

40. The apparatus of claim 1, wherein said laser comprises further a lens, said lens fixedly disposed in said laser with at least one retaining ring.

41. The apparatus of claim 1, wherein said beam-focusing telescope comprises further a lens, said lens fixedly disposed in said beam-focusing telescope with at least one retaining ring.

42. The apparatus of claim 1, wherein said laser has an output axis, said apparatus comprising further:

a third reflector aligned substantially with said output axis, said third reflector redirecting said output beam along said axis of transmission.

43. A method for laser interrogation of surface agents moving relative to an interrogator, said method comprising the steps of:

a) providing a laser;

b) outputting a substantially monochromatic beam from said laser;

c) focusing said beam with a beam-focusing telescope;

d) directing said beam at a target substance;

e) measuring a relative motion between said beam and said target substance;

f) receiving a distance-to-target signal for a point offset substantially from said target substance;

g) adjusting a focus of a receiver telescope based on said relative motion and said distance-to-target signal;

h) receiving inelastically scattered radiation from said target substance at a spectrum of wavelengths characteristic of said target substance with said receiver telescope;

i) dispersing said spectrum of wavelengths of said inelastically scattered radiation;

j) imaging said dispersed spectrum onto a focal plane array detector;

k) comparing said image of said dispersed spectrum of said target substance to an image of a spectrum of inelastically scattered radiation of a known substance; and

l) identifying said target substance if said image of said dispersed spectrum of said target substance matches substantially said image of said inelastically scattered radiation of said known substance.

44. The method of claim 43, comprising further:

m) adding said image of said dispersed spectrum of said target substance to a list of unidentified substances if said image of said dispersed spectrum of said target

substance does not substantially match an image of a spectrum of inelastically scattered radiation of a known substance.

45. The method of claim 43, said step of providing a laser comprising further:

aa) disengaging an on-board cylinder;

ab) releasing an on-board cylinder retainer;

ac) removing said on-board cylinder; and

ad) installing a new on-board cylinder.

46. The method of claim 43, said step of disengaging an on-board cylinder comprising further:

aaa) indicating a low gas bottle pressure; and

aab) locking on-board valves shut.

47. The method of claim 43, said step of installing a new on-board cylinder comprising further:

ada) purging gas lines by releasing gas from cylinder;

adb) venting gas through on-board gas filter; and

adc) replenishing a gas of said laser.

48. The method of claim 43, wherein said step of outputting a substantially monochromatic beam from said laser further comprises setting a pulse rate of said laser.

49. The method of claim 43, wherein said step of adjusting a focus of a receiver telescope comprises further:

ga) receiving a range-to-target data sample;

gb) tagging said range-to-target data sample with a time sequence;

gc) receiving a relative motion data sample;

gd) calculating a rate of change of said relative motion;

ge) correcting said range-to-target data sample for said relative motion;

gf) correcting said range-to-target data sample for rate of change of said relative motion;

gg) correcting said range-to-target data sample for a laser pulse rate;

gh) correcting said range-to-target data sample for a range-finder pulse rate;

gi) correcting said range-to-target data sample for range-finder position relative to a receiver telescope line-of-sight;

gj) correcting said tagged range-to-target data sample for a laser and rangefinder waveform de-synchronization time offset;

gk) transforming a set of co-ordinates of corrected tagged range-finder sample to a receiver telescope line-of-sight; and

gl) converting said range-to-target sample to an equivalent receiver telescope secondary reflector position.

50. The method of claim 43, wherein said step of identifying said target substance is carried out substantially in real time.

51. A apparatus for laser interrogation of surface agents moving relative to the apparatus, said apparatus comprising:

a laser, said laser outputting an output beam;

a beam-focusing telescope having a axis of transmission, said beam-focusing telescope receiving and focusing substantially said output beam;

a first reflector substantially aligned with said axis of transmission for directing said output beam in a first direction, said first direction being substantially perpendicular to the axis of transmission;

a second reflector substantially aligned with said first direction for directing said output beam in a second direction, said second direction being substantially perpendicular to said first direction;

a receiver telescope, said receiver telescope having a focal direction substantially opposite to said second direction, said receiver telescope collecting at least some radiation scattered inelastically from a target;

a spectrograph, said spectrograph receiving at least some of said inelastically scattered radiation from said receiver telescope; and

wherein said laser emits pulses at a pulse rate, and said pulse rate is selected from the group consisting of:

a predetermined pulse rate,

a variable pulse rate,

an operator-controlled pulse rate, and

a pulse rate proportional to a rate of relative motion of said target relative to said apparatus.

52. A system for laser interrogation of surface agents moving relative to the system, said system comprising:

a laser, said laser outputting an output beam;

a beam-focusing telescope having a axis of transmission, said beam-focusing telescope receiving and focusing substantially said output beam;

a first reflector substantially aligned with said axis of transmission for directing said output beam in a first direction, said first direction being substantially perpendicular to the axis of transmission;

a second reflector substantially aligned with said first direction for directing said output beam in a second direction, said second direction being substantially perpendicular to said first direction;

a receiver telescope, said receiver telescope having a focal direction substantially opposite to said second direction, said receiver telescope comprising further:

a primary reflector, said primary reflector disposed to reflect at least some radiation scattered inelastically from a target;

a focusable secondary reflector disposed to reflect and focus said inelastically scattered radiation toward a first focal point;

a secondary reflector focusing mechanism to move said focusable secondary reflector along said focal direction;

a spectrograph, said spectrograph receiving said inelastically scattered radiation from said receiver telescope;

means for range finding, said range finding means outputting a distance-to-target signal in a third direction;

wherein said third direction is at a predetermined angle to said second direction in a direction of said relative motion; and

wherein said focusing mechanism moves said secondary reflector based on said distance-to-target signal and a rate of said relative motion to focus substantially said inelastically scattered radiation at said first focal point.

53. An apparatus for laser interrogation of surface agents moving relative to the apparatus, said apparatus comprising:

an aluminum honeycomb structure;

a laser fixedly disposed on said structure, said laser outputting an output beam;

a beam-focusing telescope fixedly disposed on said structure and having a axis of transmission, said beam-focusing telescope receiving and focusing substantially said output beam;

a first reflector fixedly disposed on said structure and substantially aligned with said axis of transmission for directing said output beam in a first direction, said first direction being substantially perpendicular to the axis of transmission;

a second reflector fixedly disposed on said structure and substantially aligned with said first direction for directing said output beam in a second direction, said second direction being substantially perpendicular to said first direction;

a receiver telescope, said receiver telescope having a focal direction substantially opposite to said second direction, said receiver telescope comprising further:

a primary reflector, said primary reflector disposed to reflect at least some radiation scattered inelastically from a target;

a focusable secondary reflector disposed to reflect and focus said inelastically scattered radiation toward a first focal point;

a secondary reflector focusing mechanism to move said focusable secondary reflector along said focal direction;

a spectrograph fixedly disposed on said structure, said spectrograph receiving said inelastically scattered radiation from said receiver telescope;

a range-finder fixedly disposed on said structure and outputting a distance-to-target signal;

wherein said focusing mechanism focuses said secondary reflector based on said distance-to-target signal.

54. The apparatus of claim 53, wherein said structure comprises a predetermined coefficient of thermal expansion.

55. The apparatus of claim 53, wherein said laser, said beam-focusing telescope, said first reflector, said second reflector, said receiver telescope, said primary reflector, said focusable secondary reflector, and said range-finder comprise further said predetermined coefficient of thermal expansion.

56. The apparatus of claim 53, wherein said aluminum honeycomb structure comprises further a carbon epoxy covering.

57. The apparatus of claim 53, wherein each of said laser, said beam-focusing telescope, said first reflector, said second reflector, and said receiver telescope are fixedly disposed on said structure with a fastener, said fastener selected from the group consisting of:

a screw,

a bolt,

a rivet, and

a pin.

58. An apparatus for laser interrogation of surface agents moving relative to the apparatus, said apparatus comprising:

a laser, said laser outputting an output beam;

a beam-focusing telescope having a axis of transmission, said beam-focusing telescope receiving and focusing substantially said output beam;

a first reflector substantially aligned with said axis of transmission for directing said output beam in a first direction, said first direction being substantially perpendicular to the axis of transmission;

a second reflector substantially aligned with said first direction for directing said output beam in a second direction, said second direction being substantially perpendicular to said first direction;

a receiver telescope, said receiver telescope having a focal direction substantially opposite to said second direction, said receiver telescope comprising further:

a primary reflector, said primary reflector disposed to reflect at least some radiation scattered inelastically from a target;

a focusable secondary reflector disposed to reflect and focus said inelastically scattered radiation toward a first focal point;

a secondary reflector focusing mechanism to move said focusable secondary reflector along said focal direction;

an optical fiber having a first end and a second end coupling said inelastically scattered radiation from said receiver telescope to a spectrograph;

said first end being substantially coincident with said first focal point to collect said inelastically scattered radiation;

said spectrograph comprising further:

a parabolic reflector, said second end being substantially coincident with a focal point of said parabolic reflector to disperse said inelastically scattered radiation;

said parabolic reflector disposed to reflect said dispersed inelastically scattered radiation toward a diffraction grating said second end being integral to said diffraction grating, said diffraction grating diffracting said dispersed inelastically scattered radiation; and

a focal plane array detector receiving said diffracted inelastically scattered radiation;

a range-finder outputting a distance-to-target signal;

wherein said focusing mechanism focuses said secondary reflector based on said distance-to-target signal.

59. The apparatus of claim 58, wherein said optical fiber comprises a bundle of optical fibers.

60. The apparatus of claim 58, wherein:

said focal plane array detector has a first predetermined geometry;

said optical fiber comprises a circular-to-line optical fiber having a second predetermined geometry; and

said second predetermined geometry matches said first predetermined geometry.